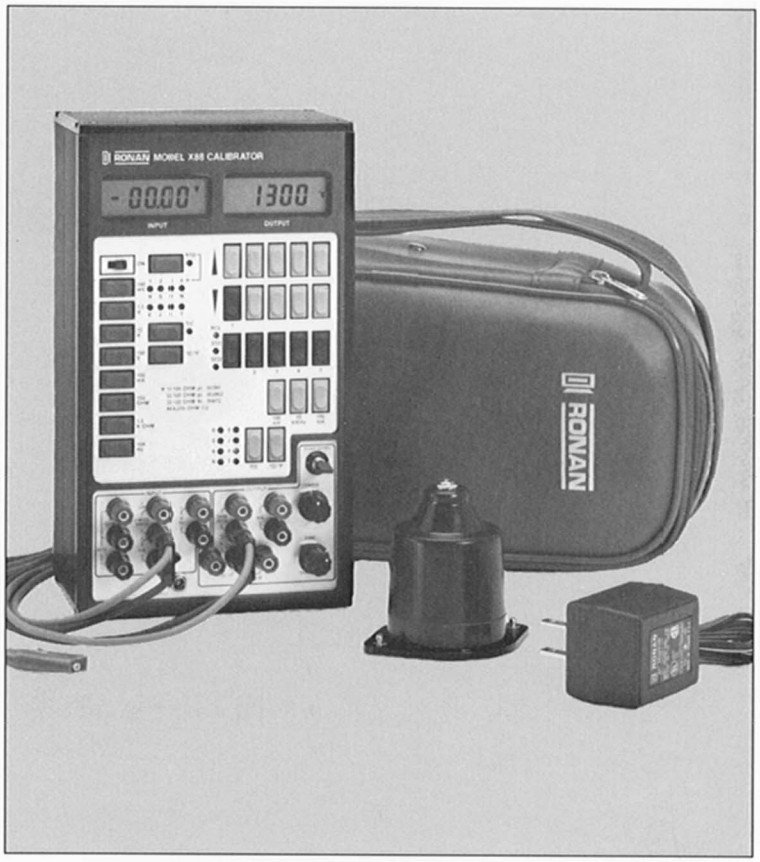
Instructions and Operating Manual

MODEL X88

PORTABLE CALIBRATOR



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WARRANTY

Ronan warrants equipment of its own manufacture to be free from defects in material and workmanship under normal conditions of use and service, and will repair or replace any component found to be defective, on its return, transportation charges prepaid, within one year of its original purchase. This warranty carries no liability, either expressed or implied, beyond our obligation to replace the unit which carries the warranty.

1.0 GENERAL DESCRIPTION

The Ronan Model X88 Portable Calibrator is a uniquely versatile instrument designed to calibrate and measure instruments, devices, and systems, utilizing current, voltage, ohms, frequency, RTD and thermocouple inputs or outputs. The Model X88 provides internal reference junctions for both thermocouple inputs and outputs and provides selectable °F or °C operations on both input and output for up to eight thermocouple types and four RTD types. The calibrator has separate, isolated input and output sections each with full range selection and displays.

The Model X88 also provides a +24 Vdc power supply at its input section to supply power to a two-wire transmitter, whose current it monitors and displays.

2.0 SPECIFICATIONS

Specifications apply at 23 ± 2°C unless otherwise stated. Specifications are subject to change without notice. Recalibration period is 6 months.

2.1 Input

Input Impedence:
Voltage, TC Inputs: 10 Mohms.
Current Input: 10 ohms.
Ohms, RTD Inputs: 1 mA from internal current source.
Hz Input: 100 Kohms.
Temperature Effects:
mV, V, mA Input: ±0.001% of range ±0.003% of reading/°C.
Ohms, RTD Input: ±0.001% of range ±0.005% of reading/°C.
T/C Input: ±0.001% of range ±.003% of reading ±0.01 deg./°C–0 to 40°C.
Hz Input: ±0.015% of reading /°C.

Linear Input Ranges	Range	Resolution	Accuracy
mV	±150 mV	10 µV	±0.01% range, ±0.02% reading
V	±1.5 V	100 µV	±0.01% range, ±0.02% reading
V	±15.0 V	1 mV	±0.01% range, ±0.02% reading
V	±150 V	10 mV	±0.01% range, ±0.02% reading
mA	±100 mA	10 µA	±0.01% range, ±0.02% reading
ohms	±150 ohms	0.01 ohm	±0.01% range, ±0.02% reading
ohms	±1.5 Kohms	0.1 ohm	±0.01% range, ±0.02% reading
Hz	10 Hz to KHz 0.2 to 10 V PK	1 Hz	±0.15% range

Table 2-1: Linear Input Ranges.

Two-wire Transmitter Power Supply: +24 Vdc at 20 mA is available at input binding post.
Input Indicator: 4-1/2 digit liquid crystal display with range legends.

Input Sensor	Range	Resolution	Accuracy
E T/C	-200°C to +1000°C	-200°C to -155°C: 1 to 2°C	±2°C ±30µV
		-155°C to +1000°C: 1°C	±1°C ±30 µV
	-328°F to +1830°F	-328°F to -265°F: 1 to 3°F	±3°F ±30µV
		-265°F to +145°F: 1 to 2°F	±2°F ±30µV
		+145°F to +1830°F: 1°F	±1°F ±30 µV
J T/C	-200°C to +1025°C	1°C	±1°C ±30 µV
	-328°F to 1830°F	1°F	±1°F ±30 µV
K T/C	-200°C to +1370°C	1°C	±1°C ±30 µV
	-328°F to +2498°F	-328°F to -220°F: 1 to 2°F	±1°F ±30 µV
		-220°F to +2498°F: 1°F	±1°F ±30 µV
T T/C	-215°C to +400°C	1°C	±1°C ±30 µV
	-355°F to +750°F	-355°F to -200°F: 1 to 2°F	±2°F ±30µV
		-200°F to +750°F: 1°F	±1°F ±30 µV
R T/C	0°C to 1760°C	1°C	±1°C ±15 µV
	32°F to 3200°F	32°F to 485°F: 1 to 2°F	±2°F ±15µV
		485°F to 3200°F: 1°F	±1°F ±15 µV
S T/C	0°C to 1760°C	1°C	±1°C ±15 µV
	32°F to 3200°F	32°F to 645°F: 1 to 2°F	±1°F ±15 µV
		645°F to 3200°F: 1°F	±1°F ±15 µV
B T/C	250°C to 1650°C	250°C to 500°C: 1 to 2°C	±2°C ±15µV
		500°C to 1650°C: 1°C	±2°C ±15µV
	440°F to 3000°F	440°F to 840°F: 2 to 4°F	±3°F ±15µV
		840°F to 1840°F: 2°F	±3°F ±15µV
		1840°F to 3000°F: 1°F	±2°F ±15µV
N T/C	0°C to 1300°C	1°C	±1°C ±30 µV
	32°F to 2370°F	1°F	±1°F ±30 µV

Table 2-2: Thermocouple Temperature Input Ranges.

Input Sensor	Range	Resolution	Accuracy
100 Ohm Pt. RTD α = 0.00385	-100°C to 790°C -100°F to 1450°F	0.5°C 0.5°F	±0.5°C ±0.5°F
100 Ohm Pt. RTD α = 0.003902	-100°C to 650°C -100°F to 1200°F	0.5°C 0.5°F	±0.5°C ±0.5°F
120 Ohm Pt. RTD α = 0.00672	-75°C to 250°C -100°F to 480°F	0.5°C 0.5°F	±1°C ±1°F
9.035 Ohm Cu RTD (10Ω at 25°C)	-100°C to 260°C -148°F to 500°F	0.5°C 0.5°F	±0.5°C ±1°F

Table 2-3: RTD Temperature Input Ranges.

2.2 Output

Output Impedance:
mV, Volts, Temperature Output: Less than 0.25 ohm.
mA Output: Greater than 1 Mohm.
Frequency Output: Transistor switches to ground with 10 K pull up resistor to +5 Vdc.

Output Current:
mV, Volts, Temperature Outputs: 10 mA, overcurrent indicator at approximately 15 mA.

Two-wire Transmitter Simulation: A 2-wire transmitter can be simulated at the "2-WIRE SIM" binding posts. Maximum external power supply 50 Vdc.

Load Resistance:

$$R_{LOAD} = \frac{\text{SUPPLY VOLTAGE - 4V}}{\text{MAX. LOAD CURRENT}}$$

Out of Range Indication:
Flashing of the most significant "1" digit on the display indicates one of the following conditions:

a) The calibrator is set to the mA output range and the output loop is open.
b) The calibrator is set to the mA output range and the loop voltage drop is too high.
c) The calibrator is set to the mA output range and the display is set to more than 99.99 mA.
d) The calibrator is set to the mV or V output range and the display is set to more than 10.999 V or 109.99 mV.
e) The calibrator is set to mV, V or T/C output ranges and the output current reaches 15 mA or greater.
f) The calibrator is set to a T/C output and the display is out of the T/C's range.

RTD/Ohms Output: Measured by RTD, Ohms input, specifications same as input.

Coarse: A 1000 ohm potentiometer is used to adjust output resistance with 0.2 ohm resolution.

Fine: A 100 ohm potentiometer is used to provide fine adjustment of output resistance with 0.06 ohm resolution.

Read Ohms: Toggle switch used to momentarily switch the resistance to the calibrator's OHMS input terminals for

Linear Output Ranges	Range	Resolution	Accuracy
mV	0 to 100 mV	10 µV	±0.02% or range ±0.01% of reading
10 V	0 to 10 V	1 mV	±0.02% or range ±0.01% of reading
100 mA	to 100 mA	10 µA	±0.02% or range±0.01% of reading
10 KHz	1 Hz to 10 KHz (0 to 5 V sq. wave with 10 K pull-up res.)	1Hz	±0.05% of range

Table 2-4: Linear Output Ranges.

T/C Output	Range	Resolution	Accuracy (Incudes Reference Junction)
E T/C	-210 to 1000°C -340 to 1832°F	1°C 1°F	1°C ±20 µV 1.5°F ±20 µV
J T/C	-210 to 1200°C -340 to 1999°F	1°C 1°F	1°C ±20 µV 1.5°F ±20 µV
K T/C	-210 to 1372°C -340 to 1999°F	1°C 1°F	1°C ±20 µV 1.5°F ±20 µV
T T/C	-270 to 400°C -450 to 750°F	1°C 1°F	1°C ±20 µV 1.5°F ±20 µV
R T/C	0 to 1765°C 40 to 1999°F	1°C 1°F or 5 µV	1°C ±20 µV 1.5°F ±20 µV
S T/C	0 to 1765°C 40 to 1999°F	1°C 1°F or 5 µV	1°C ±20 µV 1.5°F ±20 µV
B T/C	50 to 1665°C 100 to 1999°F	1°C or 5 µV 1°F or 5 µV	1°C ±20 µV 1.5°F ±20 µV
N T/C	0 to 1300°C 40 to 1999°F	1°C 1°F	1°C ±20 µV 1.5°F ±20 µV

Table 2-5: Thermocouple Output Ranges.

readout of the resistance or RTD temperature. The input must be on the ohms or required RTD range.

Temperature Coefficient:
0 to 50°C (T/C: 25 ±15°C).
mV, V Output: ±0.001% of Range, ±0.003% of Reading/°C.
mA, Output: ±0.001% of Range, ±0.005% of Reading/°C.
Frequency Output: ±0.007% of Reading/°C.
R, S, B T/C Output: ±1.0µV, ±0.003% of Reading/°C.
N, E, J, K, T T/C Output: ±2µV ±.003% of Reading/°C.

2.3 General Specifications

Low Battery Indications: Lo BAT on output display indicates battery voltage is below operating range and requires recharging.

Battery Recharge Time: 15 hours using the Ronan supplied charger.

Battery Life:
Greater than 6 hours on all functions except:
a) mA out use is > 3.5 hours at 20 mA.
b) Using 2-wire transmitter power supply, > 3 hours at 12 mA average transmitter current.

Charger and Battery: A connector for the battery charger input is located at the front panel. Battery is accessible from the bottom of the calibrator.

Recommended Operating Temperature: 0 to 50°C.

Input-to-output Isolation: 300 Vrms.

Warm-up Time: Two minutes to rated specifications.

Weight: 4 lbs.

Size: 9.2" (23.4 cm) High, 5.276" (13.4 cm) Wide, 4.00" (10.16 cm) Deep.

Accessories: Carrying case, battery charger, and two sets of test leads are supplied with calibrator.

Traceability: The X88 is directly traceable to NIST.

3.0 OPERATION

The Model X88 features straight forward range and value selection through the use of push-button switches. Up to five output values can be stored and recalled from internal memory at the touch of a button. The stored values are retained in memory when the calibrator power is off, and available for use when the calibrator is again powered on.

NOTE: When the battery is unplugged from the calibrator, the memory will lose the stored data. When first turned on after battery reconnection, the display may come up with invalid characters. When this happens, press each of the ↑ buttons, in turn to "roll" the display digits to "0" or other valid numbers. Store "0"s or other numbers in each of the five memory locations. The data in the "1" location is displayed whenever the calibrator is subsequently turned off and on.

3.1 Operating Controls

Refer to Figure 3-1 for the operating control location.

3.1.1 ON/OFF Switch: Causes the calibrator circuitry to be energized by the internal ni-cad battery.

3.1.2 Input Range Switches: One of eight input ranges is selected by pressing the associated push-button switch.

a) *150 mV:* Measures dc voltages in the range of 0 to ±150 mV with 10 microvolt resolution.
b) *1.5 V:* Measures dc voltages in the range of 0 to ±1.5 V with 100 microvolt resolution.
c) *15 V:* Measures dc voltages in the range of 0 to ±15 V with one millivolt resolution.
d) *150 V:* Measures dc voltages in the range of 0 to ±150 V with 10 mV resolution.
e) *100 mA:* Measures dc current in the range of 0 to ±100 mA with 10 microamp resolution.
f) *150 Ohms:* Measures resistances in the range of 0-150 ohms with 10 milli-ohm resolution.
g) 1.5 Kohms: Measures resistance in the range of 0-1.5 Kohms with 0.1 resolution.
h) *10 KHz:* Measures frequency in the range of 10 to 10 KHz with 1 Hz resolution.
i) *RTD Switch:* Select one of four RTD input ranges.
   1) Pt, 100 ohms 0.00385
   2) Pt, 100 ohms 0.003902
   3) Ni, 120 ohms 0.00672
   4) Cu, 9.035 ohms (10Ω at 25°C)

j) *T/C Switch:* Selects one of eight T/C input ranges: R, S, B, N, E, J, K or T Type Thermocouple.
k) *°C / °F Switch:* Selects temperature display in °C or °F for RTD and T/C inputs.

3.1.3 Output Range Switches: One of five output functions is selected through the use of the following switches:
a) *100 mV:* Outputs dc voltages in the range of 0-109.99 mV with 10 microvolt resolution.
b) *10 V:* Outputs dc voltages in the range of 0-10.999 V with one millivolt resolution.
c) *10KHz:* Outputs frequency (square wave) in the range of 0 to 10 KHz with one Hz resolution. (Dual function switch toggles between 10 V and 10 KHz ranges when pressed.)
d) *100 mA:* Outputs dc current in the range 0-100 mA with 10 µA resolution.
e) *T/C:* Outputs the millivolt equivalent of the selected T/C, and temperature indicated on the display. Up to eight T/C Types (E, J, K, T, R, S, B and N). Resolution is 15 µV for E, J, K and T, and 5 µV for R, S, B and N. An associated switch selects °F or °C.

NOTE: The Model X88 Calibrator provides a variable output resistance which is always available at the ohm output terminals.

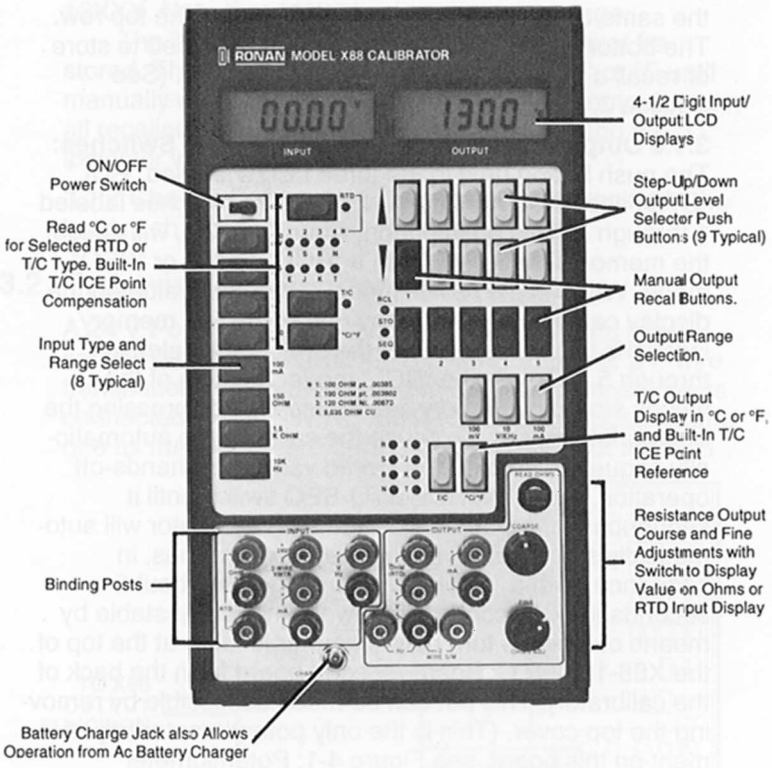


Figure 3-1: Model X88 Calibrator Operating Controls.

3.1.4 Ohms Coarse and Fine Adjustment Controls and Read Ohms Switch: These controls are used to set the output resistance. An isolated, passive resistor is internally connected across the ohm output terminals. To read the value of this resistance and adjust it, the input must be set to one of the ohms or RTD ranges and the momentary "READ OHMS" switch must be pressed. The resistor value, or corresponding temperature value for RTD ranges, will be displayed on the input meter and can be adusted using the 10-turn COARSE and FINE controls. When the READ OHMS switch is released, the resistor will be switched back to the ohms output terminals. CAUTION: If a voltage is connected to the input terminals, the +V input must be removed from the calibrator while depressing the READ OHMS switch to measure the ohms output, or an erroneous measurement will result.

3.1.5 mV, V, mA, Hz Temperature Output Adjustment: There are two rows of five push-button switches located just below the output value display. The top row, marked ▲, increments the output value on an individual digit basis. The bottom row, marked ▼, decrements the individual digits. The top four switches on the right correspond to the four output digits, which range from 0-9. The top left switch changes the 1 digit from zero to one to zero, etc. The four switches in the row under these correspond to the same digits as the right four switches of the top row. The bottom left switch is labeled "1" and is used to store or recall a complete display from memory "1". (See Section 3.1.6.)

3.1.6 Output Value Recall/Store/Sequence Switches: The push button next to the three LED's labeled "RCL", "STO" and "SEQ" functions with the five switches labeled 1 through 5. This push button, when pressed, will cause the memory function to go to a "RCL", "STO" or "SEQ" mode. When in the "STO" mode, the output value on the display can be stored into any one of the five memory locations by pressing one of the switches labeled 1 through 5. When in the "RCL" mode, any one of the values stored in memory can be recalled by pressing the appropriate switch. To cause the calibrator to automatically sequence through the stored values for "hands-off" operation, press the RCL-STO-SEQ switch until it sequences to the "SEQ" position. The calibrator will automatically step through all five memory locations, in sequence, with a "dwell" time ranging from about 5 seconds to 50 seconds. The dwell time is adjustable by means of a single turn potentiometer located at the top of the X88-1002 P.C. Board (second board from the back of the calibrator). This pot can be made accessible by removing the top cover. (This is the only potentiometer adjustment on this board, see Figure 4-1: Potentiometer Access).

Values to be Stored		Memory Locations Used	
mA, mV, V, Hz	T/C Temperature		
(1) to (5) nos. less than 10000	(1) to (5) "+" temps.	1, 2, 3, 4, or 5 in any order	
(1) five digit no. and	(1) "-" temp. and	1	or 2
(1) to (4) nos. < five digits	(1) to (4) "+" temps.	2, 3, 4, 5	3, 4, 5, 1
(2) five digit nos. and	(2) "-" temps. and	1, 2	
(1) to (3) nos. < five digits	(1) to (3) "+" temps.	3, 4, 5	
(3) five digit nos. and	(3) "-" temps. and	3, 4, 5	
(1) or (2) nos. < five digits	(1) or (2) "+" temps.	1, 2	
(4) five digit nos. and	(4) "-" temps. and	2, 3, 4, 5	or 3, 4, 5, 1
(1) no. < five digits	(1) "+" temp.	1	2
(5) five digit nos.	(5) "-" temps.	1, 2, 3, 4, 5	

Table 3-1: "STO" Memory Locations.

In general, any output value can be stored in any memory location, however, there are some special cases which have to be stored in a specific manner. These special cases occur when "-" temperatures or numbers greater than 9-9-9-9 are to be stored. Table 3-1 indicates the correct way to store "-" thermocouple temperatures (only applicable to type E, J, K and T T/C's) and linear values of 10XXX. Note that 11XXX values are over range.

The °C and °F temperature symbols cannot be stored. The calibrator output will remain in °C or °F until manually changed. For example, if in the °C output mode, all recalled temperature values will be in °C and the °C indicator will remain on the display.

3.1.7 Charge Connector: Receptacle for plugging in the battery charger.

3.2 Two-wire Transmitter Calibration

A 24 V Power Supply is available (input binding post section labeled "2-WIRE XMTR +24V" to power a 2-wire transmitter. The return wire from the 2-wire transmitter is connected to the 2-WIRE XMTR " - " binding post. (Same one as mA "+") (See Figure 3-2). The mA input function

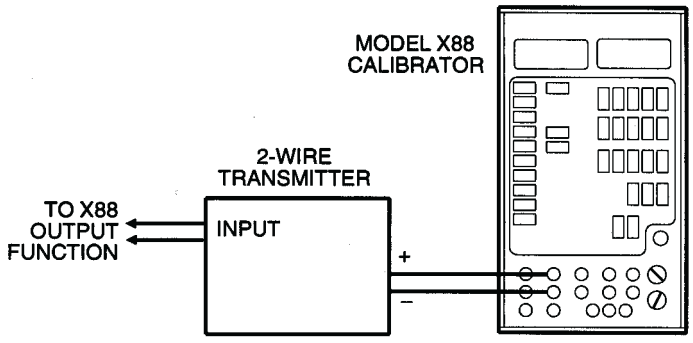


Figure 3-2: Two-wire Transmitter Calibration.

should be selected and the calibrator will display the mA flowing in the 2-wire transmitter loop. If a calibration input to the 2-wire transmitter is required, use the appropriate calibration signal from the Model X88's output.

3.3 Two-wire Transmitter Simulation

The binding posts located in the output section and labeled "2-WIRE SIM +" and "-" are to be used for 2-wire transmitter simulation. (See Figure 3-3). Set the calibrator output function to mA and set the output to 4.00 mA. (The "1" digit on the output display will flash until power is applied to the 2-WIRE SIM binding posts.) Connect the external power supply, 50 V max., and the loop instruments to the 2-WIRE SIM binding posts. The + potential side of the power supply should connect to the "+" binding posts. Set the mA output as required to perform the calibration.

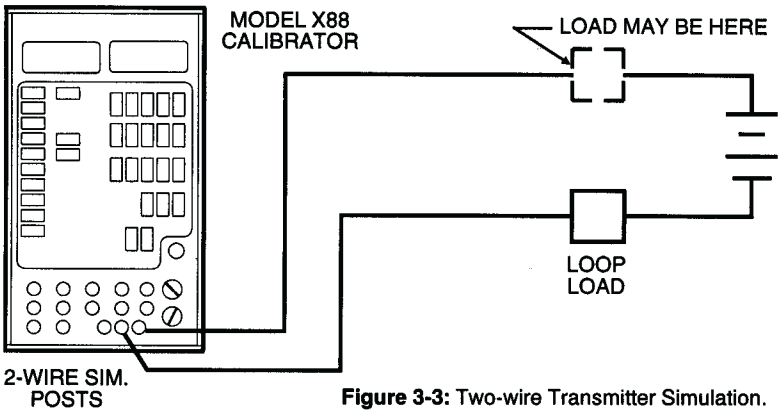


Figure 3-3: Two-wire Transmitter Simulation.

3.4 Thermocouple Inputs

The Model X88 measures thermocouples, utilizing an internal 0°C reference junction, providing a readout in °F or °C. The thermocouple (T/C) is connected directly to the V input binding posts, observing the normal polarity. (NOTE: most T/C's indicate the negative polarity side with a red colored insulation.) Internal linearization is provided for eight different T/C's. Press the T/C switch to put the calibrator in the T/C measurement mode. When first pressed, the LED at T/C selection "R" will illuminate. Each successive pressing of the T/C switch will sequence the selection of the T/C type to be measured through types S, B, N, E, J, K and T. The °C/°F switch, just below the T/C switch, selects °C or °F for the display. (A °C or °F legend on the display will indicate which is selected.)

3.5 RTD Inputs

Three binding posts are provided for RTD inputs. These are at the left of the INPUT section and are labeled "RTD '+', '-' and 'C' ". A 3-wire RTD should use all three binding

posts with "+", "-" and common leads connecting to the corresponding binding posts. If a 4-wire RTD is to be measured, connect it as if it were a 3-wire RTD. (Either the "+" V or "+" sense lead will not be connected to the X88 Calibrator.) If a two-wire RTD is to be measured, connect it to the RTD "+" and "-" posts. (Two-wire measurements will contain an error depending on the gauge and length of the lead wires. The wire resistance adds to the RTD value. This error is not present when measuring 3-wire or 4-wire RTD's). Press the RTD switch to put the calibrator in the RTD measurement mode-the LED at position "1" will illuminate. Subsequent pressing of the RTD switch will sequence the RTD selection to "2", "3", "4" and back to position "1". A table is located on the front of the calibrator which indicates which type of RTD is selected. Position 1 is for a 100 ohm pt RTD with a α = 0.00385 (DIN 43760). Position 2 is for a 100 ohm pt RTD with α = 0.003902. Position 3 is for a 120 ohm Ni RTD with α = 0.00672. Position 4 is for 9.035 ohm CU (10Ω at 25°C) RTD's. The °C/°F switch, just below the T/C switch, selects °C or °F for the display.

3.6 Thermocouple Outputs and °C/°F Switch

The Model X88 simulates one of eight thermocouples at its "V" output terminals. The T/C output function includes an internal 0°C reference junction and outputs a T/C voltage equivalent to the temperature selected on the output display. Thermocouple wire, not copper, should be connected to the "V" output posts when simulating a T/C. (Copper wires could be used when connecting to an instrument that also has an internal 0°C reference junction. In this instance, there will be an error equal to the difference in temperature at the terminals of the two separate devices.) To put the calibrator in the temperature output mode, press the T/C switch on the output side of the calibrator. The LED will illuminate indicating that the R T/C type is selected. Each subsequent pressing of the output T/C switch will sequence through each of the eight output T/C types. The °C/°F switch next to the T/C switch selects the output in °C or °F. (A °C or °F legend on the display will indicate which is selected.) Thermocouple outputs at minus temperature can be selected by the °C/°F switch. When going into the T/C output mode the display will normally display °C ("+" is implied). Pressing the °C/°F switch will cause the output "-" legend on the display to illuminate indicating "-" temperature outputs. Pressing this switch one more time will change the display to °F (+). Pressing the switch one more time changes the display to "-" °F, and the next press returns to °C (+). ("-" temperature output values apply only to the T/C types E, J, K and T.)

3.7 10 V/KHz Output Switch Function

The 10 V/KHz switch selects either the 10 V or the 10 KHz output range on alternate pressings of the switch. Legends on the output display, "V" or "Hz" indicate which function is selected. The V output is at the pair of binding posts labeled "V+" and "V-". The Hz output is available at the pair of binding posts labeled Hz+ and Hz-. This output is a 0 to 5 V square wave with a 1 K pull-up resistor and a transistor switch to ground.

3.8 RTD and Ohms Outputs

Refer to Section 3.1.4 for setting up the calibrator for RTD and ohms outputs.

3.9 Input Overrange Indication

When an overrange input is applied to the Model X88 Calibrator, the "1" digit will flash to indicate this condition. For the 150 mV, 1.5 V, 15 V, 150 V, 150 ohm and 1.5 Kohm ranges the full scale input is ±149.99 mV, ±1.4999 V, ±14.999 V, ±149.99 V, 149.99 ohms and 1.4999 Kohms respectively. For inputs exceeding these ranges, the most significant "1" digit will flash and the full scale value will remain on the display. The mA and Hz inputs are specified to 100 mA and 10 KHz but will indicate up to 149.99 mA and 14.999 Hz. Over these values the "1" digit will flash.

3.10 Output Overrange, Overload and Open Circuit Indication

When the calibrator's output is set to the mA range and there is no current loop connected to its mA output posts or the loop resistance is too high, the "1" digit on the output display will flash. The flashing "1" will also occur in the mA mode if the output is set to more than 99.99 mA.

When the calibrator's output is set to the V, mV or T/C mode and excessive current is drawn from its output (greater than approximately 15 mA), the "1" digit will flash. The "1" digit will also flash if the output is set higher than 109.99 mV or 10.999 V.

For T/C outputs, the "1" digit will flash whenever the output temperature set on the display is out of range for the selected T/C. The maximum valid amount of degrees that can be set on the display is +1999°F. Types J, K, R, S, B and N T/C's can go to +1999°F. R and S T/C's go to +1765°C, the equivalent of +3209°F, but can only go to 1999 in the °F output mode. Therefore, °C should be used for temperature outputs in excess of 1999°F. If an overrange occurs, and the display is 1999 or less for T/C types R, S, B and N, the output drops to 50 μV. For types E, J, K or T the output drops to -9.9 mV. If invalid outputs greater than 2000°C or °F are set on the display the "1" digit will flash and an erroneous output 2000° less than indicated will be provided.

3.11 Circuit Protection

The Volt, ohm and Hz input ranges to the Model X88 Portable Calibrator are protected against over voltages up to ±200 Vdc or peak ac without the use of fuses. The 100 mA input has a protection fuse rated 1/4 A. The volt output ranges are fuse protected against the application of a high voltage to the V output binding posts. The mA output post has limited protection against erroneous voltages being applied to them; up to approximately ±35 V. Avoid connecting the mA "+" post to the V "-" output post or the power fuse F2 will blow. The protection fuses, mA input F1, power fuse F2 and V output fuse F3 are located on the P.C. board X88-1003, nearest the back of the module.

4.0 CALIBRATION

It is recommended that the performance of the Model X88 be verified at three to six month intervals using precision standards traceable to the National Institute of Standards Technology (NIST). Internal calibration adjustments should not be performed without the use of this level of equipment. The calibrator may be returned to Ronan Engineering Company for calibration, or it may be calibrated in a qualified standards lab.

4.1 Equipment Required

The calibration set-up described below requires the minimum amount of precision equipment. Alternate calibration configurations can be used if the calibration error is sufficiently low (0.01% total calibration error).

a) Dc voltages standard, 0-10 V ±0.005% of reading ±50 microvolts or better (must have mV output range where output offset is less than 2 microvolts.)

b) Resistance standard, 100 ohms ±0.005%.

c) Nullmeter with 10 microvolts resolution or better. (The input section of the Model X88 can be used as the nullmeter.)

4.2 Input Calibration

4.2.1 Adjustment Potentiometers: The six potentiometers used to calibrate the input are located at the top of P.C. board X88-1001 and the potentiometers used to calibrate the output are at the top of P.C. board X88-1003. These potentiometers are accessible when the top cover of the calibrator is removed. See Figure 4-1, which shows the location of the adjustment potentiometers.

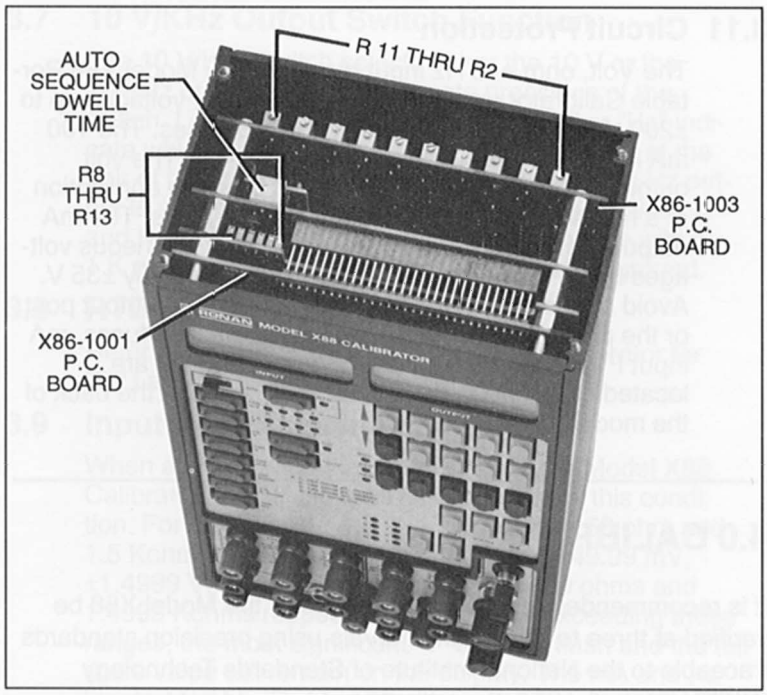


Figure 4-1: Potentiometer Access.

4.2.2 Input Zero Adjustment:

a) Set the calibrator to the 100 mV input range.

b) Plug a set of test leads into the V input posts and short the ends together.

c) The calibrator should indicate 00.00 mV on the input meter, after it has warmed up for a few minutes. Use potentiometer R8 to adjust to zero, if necessary (P.C. board X88-1001).

DVC Standard Output	Model X86 Input Range	Adjustment Potentiometer	Display
1.499 V	1.5 V	R9	1.499 V
149.99 mV	150 mV	R10	149.99 mV
14.999 V	15 V	R11	14.999 V

Table 4-1: Voltage Input Calibration.

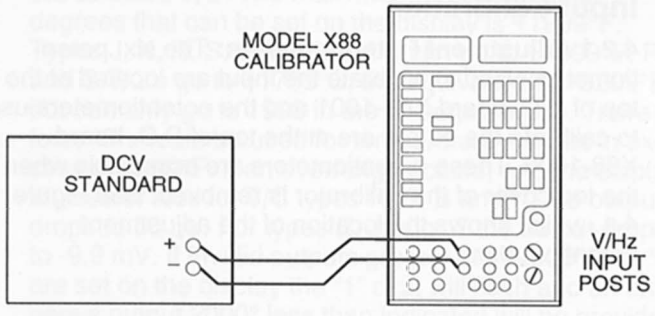


Figure 4-2: X88 Calibrator and Dc Voltage Connection.

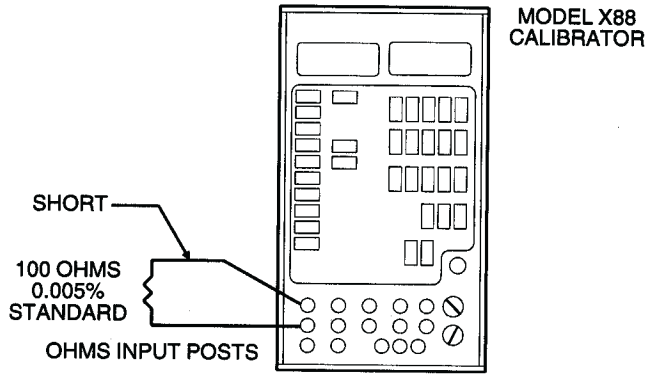


Figure 4-3: Ohms Input Calibration.

4.2.3 Input Full-scale Adjustment:

a) Connect the X88 Calibrator and the dc voltage standard as shown in Figure 4-2.
b) Set the output of the dc voltage standard and the input range of the Model X88 as shown in Table 4-1. Adjust the corresponding potentiometer listed in the right column, for the correct input meter display, if necessary.

4.2.4 Ohms Measurement Adjustment:

a) Connect the Model X88 and the precision 100 ohm resistor as shown in Figure 4-3. Connect the resistor directly to the OHM binding posts to eliminate errors caused by test lead wire.
b) Set the Model X88 input to the 150 ohm range. Potentiometer R12 should be used to adjust the input display to 100.00, if necessary.

4.2.5 Frequency Input Calibration:

a) Connect the Model X88, signal generator and frequency counter as shown in Figure 4-4.
b) Set the signal generator to a square wave output with approximately 10 V P-P amplitude at 10 KHz as measured on the frequency counter. Potentiometer R13 should be used to adjust the input display to 10.000 Hz.

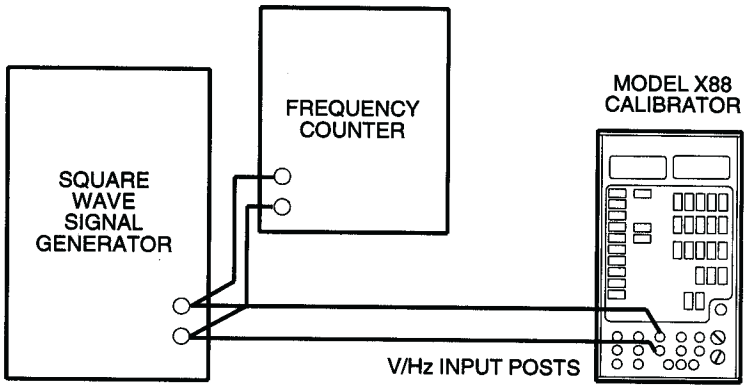


Figure 4-4: Frequency Input Calibration.

4.2.6 Thermocouple Input: The thermocouple input ranges are automatically calibrated when the mV and V input calibrations are performed. It is very difficult to check the accuracy of the thermocouple inputs because of the inherent inaccuracies of thermocouple and extension wire. Standard quality thermocouple wire exhibits errors of approximately ±2°C, (Type "T" is ±1°/C and type R and S T/C's are ±1.5°C). The following procedure is recommended for checking thermocouple input accuracy.

a) Use the test configuration shown in Figure 4-2. Select the T/C type to be measured as indicated on the Model X88's front panel.
b) Adjust the mV source for a reading of 0°C or 32°F on the display. (This should be a small negative value which cancels the internal reference junction voltage, as well as any offset voltage from the dc mV source.) Make a note of this voltage as it will be subtracted from the values from the T/C tables used later. If there is a chance that the room ambient temperature may change during the test, re-check the above to see if a new mV value is required.
c) Look up the corresponding mV value for the temperature to be measured from a temperature to mV table for the type of T/C selected on the X88. Subtract the value recorded from step b) and set the mV source to this value. The X88 displayed temperature and the temperature used from the tables should agree within the input specifictions of the Model X88 calibrator.

4.3 Output Calibration

4.3.1 Voltage Output Zero Adjustment:

a) Connect the Model X88 Portable Calibrator, the dc voltage standard and the nullmeter as shown in Figure 4-5. All potentiometer adjustments referred to in this section are located on P.C. board X88-1003.
b) Connect the two test leads to the dc voltage standard together. set the Model X88 output to the 10 V range and set the output display to 0.000 V.
c) The nullmeter should indicate 00.00±0.1mV (0.1 mV is 0.001% of range). Potentiometer R2 is used to adjust the V zero, if necessary.

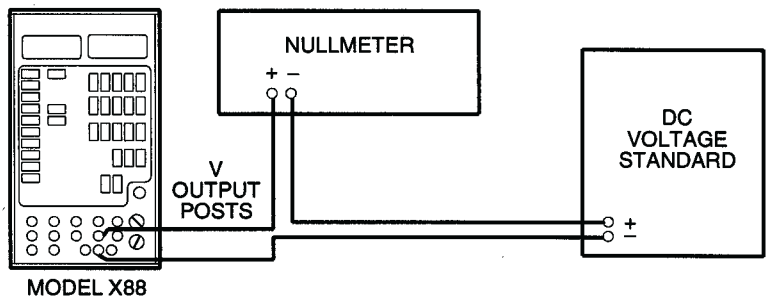


Figure 4-5: Voltage Output Measurement.

d) Set the Model X88 output to the mV range and maintain the display of 00.00 mV.

e) The nullmeter (10-microvolt resolution) should indicate 00.00 ±10 microvolts. Potentiometer R3 is used to adjust the mV zero, if necessary.

4.3.2 Voltage Output Full-scale Adjustment:

a) The test setup remains as shwon in figure 4-5.

b) Set the Model X88 output range, output value and dc voltage standard as shown in Table 4-2. Adjust the corresponding potentiometer, if necessary, to bring the error reading on the nullmeter to, or below, that given in Table 4-2.

X88 Output		Dc Voltage Standard Output	Nullmeter Reading	Adjustment Potentiometer
Range	Display			
10 V	9.999	9.999 V	0 ± 1 mV	R4
10 V	10.000 V	10.000 V	0 ± 1 mV	R5
100 mV	100.00 mV	100.00 mV	0 ± 0.01 mV	R6

Table 4-2: Output Calibration Data.

4.3.3 mA Output Adjustment: Connect the Model X88 Calibrator, the dc voltage standard, the 100-ohm precision resistor and the nullmeter as shown in Figure 4-6. NOTE: The voltage output calibration steps must be performed before the mA output adjustment is done.

a) Set the Model X88 to the mA output range.

b) Set the output display to 1.00 mA.

c) Set the dc voltage standard to 100.00 mV.

d) The nullmeter should indicate 0.0000 ± .001 V.

e) Adjust potentiometer R7 if necessary.

f) Set the Model X88 output display to 60.00 mA.

g) Set the dc voltage standard to 6.00 V.

h) The nullmeter should indicate 0.000±0.001V. Potentiometer R8 is used to adjust this value.

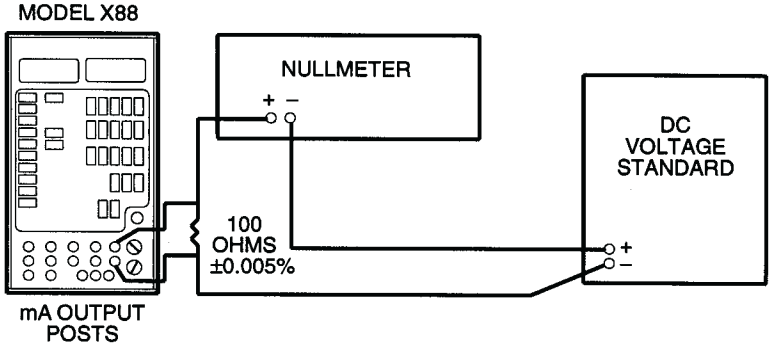


Figure 4-6: Current Output Measurement.

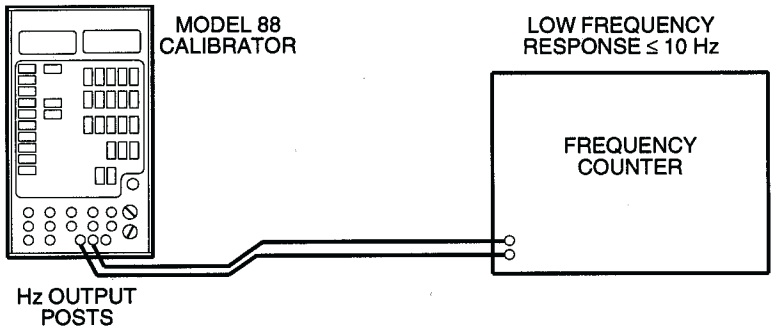


Figure 4-7: Hz Output Measurement.

4.3.4 Hz Output Calibration:

a) The Model X88 Calibrator and an accurate frequency counter should be connected as shown in Figure 4-7.

b) Set the Model X88 to the Hz output and 0010 on the display.

c) Adjust the Hz zero control, R9, for 10 Hz as measured by the frequency counter.

d) Set the Model X88 display to 10000 Hz.

e) Adjust the Hz full scale control, R10, for 10.00 KHz as measured by the frequency counter.

4.3.5 T/C Calibration, Types R, S, B and N Scaling:

Note: The mV and V zero and full scale calibration tests must be performed before the T/C calibration is undertaken.

a) Set the Model X88 input and output to the T/C range and type N T/C. Set the output to 50°F and the input to °F. Connect the V output posts to the V input posts. The input should display +50°F. R54 on the X88-1003 P.C. board is used to adjust for +50°F, if necessary. Potentiometer R54 is a single turn, 1/4" round pot located on the right edge of the the board, about mid way down.

b) Connect the Model X88 in configuration shown in Figure 4-5. (Copper wiring is to be used).

c) Select the "N" T/C output and set the temperature display to 0000°C.

d) Adjust the dc voltage standard for 00.00 on the nullmeter. This will be a small negative voltage - approximately -.5 to -.75 mV. (This is the internal reference junction voltage). Record this voltage.

e) Set the output display to +1300°C (N T/C). Set the dc voltage standard to 47.502 mV minus the absolute value recorded in Step C above.

f) Adjust the potentiometer, R11, on P.C. Board X88-1003 for a reading of 00.01±10 microvolts on the nullmeter.

g) Select the "E" T/C output range and set the display to 0000°C.

h) Multiply the voltage set on the dc voltage standard in Step D above by 2.2593 and set the dc voltage standard to this value. Reverse the leads to the dc voltage standard as the "-" input to the nullmeter now should connect to the "-" output of the voltage standard.

i) Adjust the single turn potentiometer R1 for 0.0±.01mV on the nullmeter. The back panel of the X88 must be removed to gain access to R1. (R1 is located at the upper left corner of the board and is a single turn 1/4" round potentiometer.

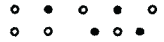
5.0 TROUBLESHOOTING GUIDE

Refer to Table 5-1 for some specific troubleshooting guidelines. Ronan Engineering Company maintains a service and repair department where the calibrator may be sent for repair and calibration.

Abnormality	Possible Cause	Corrective Action
No display.	Low or faulty battery, fuse F2, board X88-1003.	Charge battery. If battery voltage is good, check fuse F2 on PC board X88-1003.
No voltage output.	Fuse F3, board X88-1003.	Check fuse F3 and replace, if required.
Unstable output display.	Front panel switch left in SEQ. position.	Set to RCL position.
No reading on mA input. Voltage input okay.	Fuse F-1, board X88-1003.	Replacement fuse F-1.
Output display shows P's or other abnormal symbols.	Battery has been changed or disconnected.	Use up switchs to sequence display to 0's or other numbers. Store in each of the five memories.

Table 5-1: Troubleshooting Guide.

Location of red binding posts
(9 ea.) (front view).



X88 CALIBRATOR ASSEMBLY	RONAN	
	DRAWING NO. X88D27	REV. 2

NOTES:

1. Apply epoxy or Super Glue to mount on the front panel. Avoid excessive amount of glue in the cutout area.
2. Apply epoxy or Super Glue to mount on the front panel. Avoid excessive amount of glue visible from the front side of front panel.
3. Install sensor marked with white dot in mounting bracket on right side when looking at the back of the panel. Glue temperature sensors into holes provided on X88B25 brackets. Use two part epoxy, P/N 10-347 or equivalent. Mfr: GC Electronics.
4. Install spade lug on post ⚠5 between the nuts using a #6 star washer with lug.

Item No.	Qty.	Part No.	Description	Spec
1	1	X88C13	Graphic Panel (Top) [1]	Ronan
2	1	X88D11	Front Panel Base	Ronan
3	1	X86C5	Top Cover	LBM
5	1	X88B26	L.C.D. Window [2]	Ronan
6	1	X88-1000	P.C. Board, Display and Switches	Ronan
7	4	8216	4-40 M.F. Thd. Spacer	H.H. Smith
8	1	X88-1001	P.C. Board, Input Circuits	Ronan
9	4	8218	4-40 M.F. Thd. Spacer	H.H. Smith
10	1	X88-1002	P.C. Board Dac. Circuits	Ronan
11	4	8222	4-40 M.F. Thd. Spacer	H.H. Smith
12	1	X88-1003	P.C. Board, Power Supply and O.P. Amps	Ronan
13	4		4-40 x 1/4" Pan Hd. Phillips	West Valley
14	1	X88B23	Back Cover	Ronan
15	1	7760	Black Finish Nut	C & K
16	1	T-2160	Knurled Nut	Switchcraft
17	6	3015-103	Mini Binding Post, Black w/Nuts	H.H. Smith
18	9	3015-102	Mini Binding Post, Red w/Nuts [3]	H.H. Smith
19	1	X88C12	Graphic Panel (Bottom) [1]	Ronan
20	1	712A	Power Jack Receptacle	Switchcraft
21	1	7209-L41-YZBE	Toggle Switch	C & K
22	1	534-9905-101	Potentiometer, 100 Ohm w/Nut	Spectrol
23	1	534-9598-102	Potentiometer, 1 K W/Nut	Spectrol
24	2	X88B24	Extrusion	Ronan
25	8		6-32 x 3/8" Self-tap Black Pan Hd. Phillips	West Valley
26	1	X88C6	Bottom Cover	IBM
27	2	UI79136-4-4	Ultra Sonic Insert	SI
28	1	X85D32	Battery Pack Assembly	Ronan
29	1	22-01-2167	Crimp Terminal Housing	Molex
30	2	PKX-50B-1/4	Knob	Alco
31	1	X88B25-2	Mounting Bracket	Ronan
32	1	X88B25-1	Mounting Bracket	Ronan
33	16	08-55-0102	Terminals	Molex
34	2	LM35CAZ	Temperature Sensor [4]	National
35	1	104A101C20	Capacitor C2	Sprague
36	1	105R500C20	Capacitor C1	Sprague
37	4		4-40 x 1/8 Flat Hd. Phillips	West Valley
38	1		#6 Ext. Star Washer	West Valley
39	2	CS05-440	Standoff	PEM

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